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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Method and Apparatus for Roller Cleaning Electrodes

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Notice: This application is as filed and may therefore contain an incomplete specification.

Abstract of the Disclosure

A novel roller cleaner and method for cleaning scale from electrodes of electrolytic cells. In one aspect, this invention pertains to a roller anode cleaner, and a method of using it, which cleans manganese dioxide scale of anodes of electrolytic cells used in the production of zinc according to a zinc electrowinning process. A method of cleaning scale from the surface of an electrode of an electrolytic cell comprising contacting the scale on the surface of the electrode with a smooth surface rotatable and yieldable member with a force which is sufficient to dislodge the scale from the electrode at the interface between the scale and the electrode and leaves the surface of the electrode intact.

METHOD AND APPARATUS FOR ROLLER CLEANING ELECTRODES

FIELD OF THE INVENTION

This invention relates to a novel roller cleaner and a method of using the roller cleaner for cleaning scale from electrodes of electrolytic cells. In one aspect, this invention pertains to a roller anode cleaner, and a method of using it to clean manganese dioxide scale of anodes of electrolytic cells used in the production of zinc by a zinc electrowinning process.

BACKGROUND OF THE INVENTION

Electrolytic processes are widely used in the industrial world for the recovery or refining of metals. During the process of electrolysis for the production of metals, which are usually deposited on one or more cathode surfaces, a layer of sediment impurities contained in the electrolyte is usually deposited on one or more anode surfaces. These deposits or coatings can be either of a metallic or non-metallic nature. Non-metallic deposits or coatings are generally undesirable because they often adversely affect the efficiency of the electrolysis process. The situation deteriorates with time because the unwanted deposit or coating grows progressively thicker and increases resistance. The deposit must therefore be removed periodically from the electrode surface. Apart from the electrical resistance factor, the metallic coatings or deposits frequently contain commercially recoverable amounts of valuable metals and must be removed to enable the subsequent recovery of metal values.

In the process of electrowinning of zinc, silver-lead electrodes are used as anodes. Manganese ions in the electrolyte oxidize at the anode and form a manganese dioxide scale. Regular removal of this scale is required. Otherwise there is a tendency for the scale to cause

shortcircuiting in the cell by contacting the cathode. A scale buildup is detrimental to current distribution.

Specifically, due to electrolytic oxidation, layers of manganese dioxide slowly build up on the respective silver-lead sheet anodes used in the cell. If these layers get too thick, they lose adherence to the anode surfaces. The layers tend to separate in localized areas and form "bubbles" which eventually fall off. Once this happens, an exposed electrode surface area is left. This area either has a much thinner manganese dioxide layer, or the layer is nonexistent. These exposed areas exhibit a markedly reduced resistivity and thus cause localized high current densities, which in turn cause detrimental problems in the cell such as overheating, electrode warping, or even localized electrode melting. To avoid these problems, it becomes necessary to periodically remove at least a portion of the manganese dioxide layer from the electrode before the layer becomes too thick.

Over the years, various methods have been used or proposed for cleaning the deposits or scale from the anode. Traditionally, cleaning has been effected by hand scraping procedures. However, hand scraping is slow, laborious, inefficient and potentially hazardous. Also, damage to the surfaces of the electrodes often occurs. Surface scratches and gouges on anodes cause localized high current densities and adversely affect cell operation. Smooth, scratch and gouge free anode surfaces are preferred for even current distribution and efficient cell operation.

High pressure water sprays and/or powered rotary brushes have also been used for the removal of layers of deposits or coatings from electrodes. Steel wire, or a fibre bristle of natural or synthetic origin, are used as bristles in the brushes. These techniques, while representing an improvement over hand scraping, particularly in

terms of labour, are not ideal. Controlling the brushes so that they remove either substantially all, or exactly the right amount of scale while at the same time, avoiding damaging the electrode surface, is very difficult. Also, the brushes wear out quickly and must be replaced frequently. The brushes also tend to clog easily if the layer being removed is at all wet. Electrode brushing machines are described, for example, in United States Patents Nos. 2,220,982 (issued November 12, 1940 to P.S. Toney) and 3,501,795 (issued March 24, 1970 to P.M. Jasberg), and in United Kingdom Patent No. 1,449,545 (issued September 15, 1976 to BICC Ltd.).

When water jets are used for electrode cleaning, the run-off water must be treated to remove dislodged materials. Such materials can be valuable and warrant recovery or they can be toxic or potential pollutants. Another problem with water jets is that large amounts of water are used. Thus a relatively small amount of material must be recovered from a relatively large volume of water, which creates other problems.

An apparatus and method now used by Cominco Ltd. for the removal of impurity layers from electrodes used in the electrowinning and electrorefining processes of metals is disclosed and claimed in Canadian Patent No. 1,188,058, granted June 4, 1985, H.T. Redhead et al., and assigned to Cominco Ltd. U.S. Patent No. 4,595,421, granted June 17, 1986, is a U.S. counterpart. These two patents disclose a dry method and apparatus for the removal of at least a portion of a removable layer of adhering impurity substances from at least one surface of an electrode used in the electrolytic deposition of metals. The method comprises contacting the electrode surface with at least one cleaning means consisting of a rotating member which has attached thereto a plurality of radially projecting flexible fingers. The axis of rotation of the member is

substantially parallel to the surface of the electrode. The rotating member may be a cylindrical member and have fingers attached thereto. Or it may be a shaft having a number of arms radially attached thereto. The arms in turn have attached thereto fingers which contact the electrode.

Japanese Patent 05 65,685 (93 65,685), N. Ogawa et al., Toho Zinc Co. Ltd., published March 19, 1993, discloses an apparatus for removing anodes slime in the electrowinning of metals. This apparatus comprises twenty-one pairs of opposite-facing revolving bodies with a specified distance between the bodies. A number of impact bodies are disposed around the revolving bodies. A rotating apparatus causes the revolving and impacting bodies to rotate together. A device is used to move the revolving and impacting bodies along the front and back sides of the anode.

Canadian Patent application Serial No. 2,121,275, published March 25, 1995, S. Menendez et al., assigned to Asturiana de Zinc, S.A., discloses a procedure and machine for cleaning the anodes of electrolytic tanks. The procedure comprises mechanically breaking the deposits on the surfaces of the anodes, detaching and separating the deposits, once broken, and then subjecting the plate of the anodes to a flattening operation. The procedure is carried out with a machine which includes at least one pair of cutting rollers, nozzles for supplying jets of water under pressure situated above the rollers, two flattening plates with flat opposing surfaces, and means for suspending and raising the anodes between the rollers, nozzles and plates. The plates can be provided on their opposing surfaces with cutting grooves.

SUMMARY OF THE INVENTION

The roller anode cleaner, and a method of using it, according to the invention has been designed to remove from the anode as much scale as required, yet still leave the underlying lead oxide-rich layer on the surface of the anode relatively undisturbed. The distance between the rollers is adjustable. Other noticeable positive effects are realized, including flattening of the anode sheet, and a grinding effect which produces a finer scale for recycle as an oxidizing agent in other parts of the zinc process.

The invention is directed to a method of cleaning scale from the surface of an electrode of an electrolytic cell comprising contacting the scale on the surface of the electrode with a smooth surface rotatable and yieldable member with a force which is sufficient to dislodge the scale from the electrode at the interface between the scale and the electrode and leaves the surface of the electrode intact.

The electrode can be an anode. The scale on the surface of the anode can be contacted with a plurality of smooth surface yieldable members. The plurality of smooth surface yieldable members can contact the scale on the surface of the anode in a sequential rotational manner by being mounted on the curved periphery of a rotating skeletal drum-like member.

The plurality of smooth surface yieldable members can be cylindrical rollers. The cylindrical rollers can be hollow, and the hollow cylindrical rollers can be mounted on cylindrical rods of diameter narrower than the diameter of the hollows in the rollers which rods extend through the hollows and rotatably mount the rollers on the curved periphery of the rotatable skeletal drum member.

The plurality of first hollow rollers can be mounted end to end in series along a first longitudinal axis on the curved periphery of the skeletal drum member, said axis being parallel to the longitudinal axis of the rotating skeletal drum member.

A plurality of second hollow rollers can be mounted end to end in series on a second longitudinal axis on the curved periphery of the skeletal drum member said second axis being parallel with the first longitudinal axis and parallel with the longitudinal axis of the rotating skeletal drum member.

A plurality of third hollow rollers can be mounted end to end in series on a third longitudinal axis on the curved periphery of the skeletal drum member said third longitudinal axis being parallel with the first and second longitudinal axes, and parallel with the longitudinal axis of the rotating skeletal drum member.

The method can include a plurality of fourth, fifth and sixth hollow rollers which can be mounted end to end in series on parallel fourth, fifth and sixth longitudinal axes around the curved periphery of the skeletal drum member, and parallel with the first, second and third axes of the skeletal drum member.

The method can include a second skeletal drum member and a second plurality of first, second, third, fourth, fifth and sixth rollers on the periphery thereof, the first and second pluralities of six rollers contacting opposite sides of the surface of the anode.

In another aspect, the invention is directed to an apparatus for cleaning scale from the surface of an electrode comprising: (a) a first frame; (b) a second frame spaced from and facing the first frame (a) to provide

a space between the first and second frames for passage of an electrode through the space; (c) a first member rotatably mounted on the first frame on the side of the first frame facing the second frame; (d) a second member rotatably mounted on the first frame on the side of the first frame facing the first frame; (e) a rotatable, yieldable electrode contacting member mounted on the surface of the first member; and (f) a rotatable, yieldable electrode contacting member mounted on the surface of the second member; said first rotatable yieldable member and said second rotatable yieldable member impacting on respective first and second sides of the electrode as the electrode is passed through the space between the first and second frames.

The electrode of the apparatus can be an anode. The first member and the second member can have a skeletal cylindrical drum-like configuration, and the axes of rotation for the first and second members can be transverse to the direction of passage of the anode through the space between the first frame and second frame.

The rotatable yieldable member can be a roller, the axis of rotation of which can be parallel to the first member (c). The rotatable yieldable member can be a second roller, the axis of rotation of which can be parallel to the second member (d).

The first and second rotatable members can have a generally hollow skeletal drum-like configuration, and the axis of rotation of the first and second members can be transverse to the direction of passage of the anode through the space between the first and second members.

The first drum-like member can have six hollow cylindrical rollers spatially mounted around the periphery of the first drum-like member, the six rollers having axes

of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

The second drum-like member can have six hollow cylindrical rollers spatially mounted around the periphery of the second drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

The first and second drum-like members can be mounted on first and second shafts which can be rotatably mounted in the respective first and second frames.

The first and second rollers can be hollow cylinders and can be rotatably mounted on the peripheries of the first and second drum-like members by shafts which pass through the hollow interiors of the respective first and second rollers, said shafts being affixed to the ends of the first and second drum-like members.

The first frame can have first and third members rotatably mounted thereon in series and the second frame can have second and fourth members rotatably mounted on the second frame in series thereon. The first frame and the second frame can be pivoted relative to one another so that the top of the first frame and the second frame abut one another in a first position, and alternatively, the bottom of the first frame and the bottom of the second frame abut one another when the first and second frames are pivoted to a second position.

In another aspect, the invention is directed to an apparatus for cleaning scale from the surface of an

anode comprising: (a) a main frame; (b) a first drum rotationally mounted on the main frame; and (c) a first roller rotationally mounted on the surface of the drum, said roller being movable in a radial direction, and having an axis of rotation which is parallel to the axis of rotation of the drum, the roller impinging on the scale of the anode and separating the scale from the anode.

The anode cleaner according to the invention can include an opposing main frame, second rotating drum and second rotating roller, a space being provided between the opposing first and second drums and rollers to enable an anode to be passed through the space, the first and second rollers impinging on each side of the anode to remove scale from both sides of the anode.

The first and opposing main frames can include corresponding third and fourth rotating drums parallel with and spaced from the first and second rotating drums, the third and fourth drums having rotationally mounted thereon third and fourth rollers which rotate about axes which are parallel with the axis of rotation of the third and fourth drums. Each of the drums can have disposed around the circumference thereof at equal intervals six rollers, which can be rotationally mounted on respective roller holders.

The drums can each be constructed of a series of circular plates, spatially and radially disposed along an axle, and a plurality of rollers rotationally mounted on roller holders extending between the series of radially disposed plates. The rollers can be hollow cylinders and the roller holders can be rods extending through the interior of the hollow cylinders.

The first and second drums can each be constructed of a series of three sided spacer plates, spatially and radially disposed along a second axle

rotationally mounted in the main frame at a level below the first axle, the spacer plates having mounted on the peripheral edges thereof in equidistant relationship rollers mounted on shafts extending between peripheral edges of the spacer plates. The rollers can be hollow cylinders which can rotate on corresponding roller rods extending between peripheral points on the spacer plates.

The distance between the first main frame and the opposite main frame can be adjusted.

The spacer plate can have a general isosceles triangular shape, rollers and roller mounting rods can be mounted in the general region of the points of the isosceles triangle, and the spacer plates can be arranged radially and spatially along the lengths of the second shafts alternate in position so that rollers are disposed at 60° positions around the circumference of the second drum.

The invention is also directed to an apparatus for cleaning anodes comprising: (a) a first frame; (b) a second frame spaced from and facing the first frame to provide a space between the two frames for passage of an anode through the space; (c) a first drum-like member rotatably mounted on the first frame on the side of the frame facing the second frame; the first drum-like member having six hollow cylindrical rollers mounted around the periphery of the first drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames; (d) a second drum-like member rotatably mounted on the first frame below the first drum-like member on the side of the frame facing the second frame, the second drum-like member having six hollow cylindrical rollers mounted around the periphery of

the second drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis of rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames; (e) a third drum-like member rotatably mounted on the second frame on the side of the frame facing the first frame; the third drum-like member having six hollow cylindrical rollers mounted around the periphery of the third drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the third drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames; and (f) a fourth drum-like member rotatably mounted on the second frame below the third drum-like member on the side of the frame facing the first frame, the fourth drum-like member having six hollow cylindrical rollers mounted around the periphery of the fourth drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the fourth drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate specific embodiments of the invention, but which should not be construed as restricting the spirit or scope of the invention in any way:

Figure 1 illustrates a simplified isometric view of an anode being cleaned by the roller anode cleaner.

Figure 2 illustrates a side elevation partially in section view of the roller anode cleaner.

Figure 3 illustrates a simplified top view of the roller anode cleaner.

Figure 4 illustrates a section taken along the line 4-4 of Figure 2 with the roller anode cleaner in a first position.

Figure 5 is similar to Figure 4 but with the anode roller cleaner in a second position.

Figure 6 illustrates a stylized side view of zinc anode cleaned that has been cleaned using the rubber finger cleaner disclosed and claimed in Canadian Patent No. 1,188,058.

Figure 7 illustrates a stylized side view of an anode cleaned that has been cleaned using the anode roller cleaner according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring in turn to Figures 1 to 5 of the drawings which illustrate a preferred embodiment of the anode roller cleaner, Figure 1 illustrates an isometric view of an anode 50 being cleaned by the anode roller cleaner. The anode cleaner is constructed of a symmetrical pair of opposing vertical end frames 7. Each opposed side of the anode roller cleaner has a pair of end frames 7, spaced apart with horizontal top frames 5, central frame 6 and bottom frames 4. Extending between and supported by each pair of opposing end frames 7 are upper and lower skeletal drums 60 and 62 mounted for rotation on shafts 25 and 26 respectively. Outer plates of the upper skeletal drum 60 hold between them a series of aligned and parallel rotatable rollers 12 and 13 in a relationship that resembles a skeleton drum. Outer plates 3 of the lower skeletal drum 62 hold between them a series of aligned and

parallel rotatable rollers 14, 15 and 16 in a relationship that resembles a second skeletal drum.

The upper skeleton drum 60 and the rotatable rollers 12 and 13 can be rotated (as indicated by the arrows A) relative to the frame 7, 4 and 5, at a speed such that the series of loosely mounted rotatable rollers 12 and 13 are held radially outwardly by centrifugal force. The same is true of the lower skeleton drum 62 made up of plates 3, spacer plates 1 and rollers 14, 15 and 16 (as also indicated by the arrows B). The anode 50 can be moved upwardly or downwardly between the opposing pairs of rapidly rotating skeleton drums as indicated by the vertical two-headed arrow C. In this way, the rotating rollers 12 and 13, or alternatively, the rotating rollers 14, 15 and 16, impinge on the scale on the anode 50 and break the scale free into pieces so that they can fall down as shown by arrows D (see the downwardly falling scale at the bottom of Figure 1). The pair of frames 7 can be tilted outwardly or inwardly so that the desired rotating rollers impinge the scale on the anode 50 (see Figures 4 and 5).

Figure 2 illustrates a front view of the roller anode cleaner. As seen in Figure 2, and as briefly discussed above in relation to Figure 1, the roller anode cleaner is constructed of a pair of opposing rectangular frames which each hold between them a number of aligned and parallel metal top cylindrical rollers 12 and 13, which form an upper horizontal skeleton cylindrical drum 60 and a number of aligned and parallel bottom cylindrical rollers 14 and 15, which form a lower horizontal skeleton cylinder drum 62. Specifically, the rollers 12, 13, 14, 15 and 16 are rotationally attached in series in parallel longitudinal groups around the circumferences of upper and lower rotating skeleton metal drums 60 and 62 which have end plates 3 and interior plates 2 for the upper skeleton drums 60, and plates 3 and spacer plates 1 for the lower

skeleton drum 62. The top and bottom skeleton drums are rotated axially (see Figure 1) about their longitudinal axis by an electric motor and sheave assembly, or any other suitable drive mechanism.

As shown in Figure 2, the anode roller cleaner is constructed of a number of interacting components, some of which are moveable, and some of which are stationary. While not visible in Figure 2 (but see Figures 1, 3 and 4), a symmetrical anode roller cleaner is positioned directly behind the one that is visible in Figure 2. For ease of explanation, only one of the symmetrical pair of frames and rollers will be discussed. The main body of the anode roller cleaner is constructed of a pair of parallel facing vertical main frame end components 7, which have extending between them laterally three parallel horizontal components, namely, a top bracket 5, a middle bracket 6 and a bottom bracket 4. A rotatable top shaft 25 extends laterally between the two vertical main frame components 7, 7 in the rectangular space provided between the top bracket 5 and the middle bracket 6. The upper cylindrical skeleton drum 60 is mounted axially on the top shaft 25 and is located between the spaced pair of main frame end components 7, 7. The upper skeleton drum 60 is constructed of a series of rotatable top cylindrical rollers 12, 13, which are arranged in spaced parallel groups around the periphery of the drum on rods 39 and are rotatably held in place by end plates 3, 3, spaced internal plates 2, securing device 35, a key steel 44 which prevents the drum from rotating on the top shaft 25, and a series of upper spacer sleeves 17 and 18.

As seen in Figure 2, in the lower portion, the lower skeleton cylindrical drum 62 is constructed in somewhat similar manner to the upper skeleton drum 60. The rotatable bottom rollers 14, 15 and 16 are arranged in parallel groups in series and are rotationally mounted on

elongated longitudinally extending roller holder rods 40, which are spatially held in position relative to one another by a parallel series of circular end plates 3 and interior spacer plates 1, affixed to the bottom shaft 26, which passes transversely and horizontally between the two main frames 7, 7 in the rectangular opening below middle bracket 6 and above bottom bracket 4. It should be noted that the three sided spacer plates 1 are staggered in series relative to one another so that the adjacent rollers 14, 15 and 16 are offset. In this way, there are no continuous circumferential lines of division (gaps) between the rollers 14, 15 and 16. Thus, as the lower drum 62 and rollers 14, 15 and 16 are rotated, and contact the scale on the anode 50, all areas of the anode 50 are exposed to the rotational roller beating action of the rotating lower skeleton drum 62.

A pair of end plates 3, held in place on the bottom shaft 26 by key steel 48, hold the lower drum 62 and bottom rods 40 and spacers 1 in place and ensure that the lower drum rotates with the bottom shaft 26. Bottom spacer sleeves 23 and 24 are also shown in the lower portion of Figure 2.

Shown at the right and left of Figure 2 are a number of pieces of hardware which serve to rotationally mount the top shaft 25, the bottom shaft 26 and the middle shaft 27 in the main frame 7, 7 in order to enable the various shafts 25, 26 and 27 to rotate. These components serve the purpose of demonstrating one method of mounting and driving the upper and lower skeleton drums. It will be understood that other suitable mounting and drive mechanisms can be used without departing from the spirit and scope of the invention. The top shaft 25, bottom shaft 26 and middle shaft 27 are rotationally held by shaft holders 31, which include ball bearing elements. Corresponding hardware is shown at the left of Figure 2 at the opposite

ends of the respective shafts. Slide plates 9 are bolted to shaft and bearing holders 31 through slotted apertures (not shown) in end frame plate 7 which allow for tensioning or release of drive belts and adjustment of drums 60 and 62 into parallel relationship with anode plate 50. At respective bottom ends of the pair of main frames 7, 7, as shown in Figure 2, are mounted matching stop blocks 19, and tubing 22.

Figure 3 illustrates a simplified top view of the anode roller cleaner with opposing pairs of rollers 12, 13, 14, 15 and 16 arranged to form a central longitudinal mouth through which anode 50 (shown in dotted lines) can be raised or lowered for descaling. The anode roller cleaner can be set in a floor or on a scaffold or platform system so that the anodes can be readily lowered and raised in the mouth of the anode roller cleaner. In this way, each side of the anode is exposed to the descaling action of the rapidly rotating rollers 15 on each side.

Figure 4 illustrates a section taken along the line 4-4 of Figure 2 with the roller anode cleaner in a first position with the lower pair of skeleton drums proximate to one another. In Figure 4, the facing bottoms of the two main frames 7, 7 abut one another.

As illustrated in Figure 4, each main frame 7 (two main frames are shown in direct symmetrical opposition to one another) has an upper skeleton drum 60 constructed of six groups of upper rollers 12 and 13, mounted for rotation on top shaft 25. Each of the six rollers 13 is a hollow cylinder and is held in place by a respective rod-like roller holder 39 (see Figure 2 as well). The diameter of the roller holder 39 is considerably less than the internal diameter of the rollers 12 and 13. Thus each roller 12 and 13 has a certain amount of "play" and can move radially inwardly or outwardly. Each roller 13 is

held radially outwardly by centrifugal force when the skeleton drum is rotated at an appropriate speed. This is the position shown in Figure 4. This outward roller position, caused by centrifugal force, coupled with the radial "play" that is available, enables each of the rollers 13 in turn to contact the scale on the surface of the anode 50 and by rotation and centrifugal force "beat" the scale in a manner which dislodges the scale from the anode 50.

A corresponding bottom skeleton drum which is constructed of a series of radially disposed spacer plates 1, and end plates 3 carry rotatable hollow bottom rollers 14, 15 and 16. Each bottom roller is rotatably held in place by a rod-like bottom roller holder 40, which is of smaller diameter than the internal diameter of the hollow rollers, and thus gives the bottom rollers 14, 15 and 16 some "play". Again, since the rollers 14, 15 and 16 are held radially outwardly by centrifugal force when the bottom skeleton drum is rotating at an appropriate speed, a scale cleaning or dislodging impact action is created between the rollers 14, 15 and 16 and the scale. A pair of middle shafts 27 extend in parallel between the two spaced parallel main frames 7, 7 (see Figure 2) between the set of top rollers 12 and 13 and bottom rollers 14, 15, 16. Stop lock bracket plates 43, hold tubing 22 and adjusting screw 21 are shown at the bottom of the respective opposing pairs of matched main frames 7, 7.

A corresponding adjustment screw 21 with tubing 22 is mounted at the bottom of the opposing main frame 7. The pair of adjustment screws 21 enable the abutting distance between the bases of the matching main frame 7 to be adjusted to accommodate different widths of anode 50, and different thickness of scale on the anode. It will be noted that a corresponding set of adjustment screws are mounted at the top of the opposing main frames 7, mounted

on top stop block plates 38, and serve the same purpose of enabling adjustment to be made in the abutting distances between the tops of the opposing main frame 7.

The main frame 7 shown at the right of Figure 4, which is identical to the left frame 7, also rotationally carries a top skeleton drum and set of top rollers 13, which are rotationally mounted with "play" on respective roller holders 39. The top skeleton drum is rotationally mounted on top shaft 25, with top sleeve 17. A correspon-ding bottom skeleton drum is constructed of bottom spacer sleeves 23 and 24 encircling a bottom shaft 26, a series of spacer plates 1, spatially and radially disposed along the shaft 26, and a plurality of bottom rollers 14, 15 and 16, rotationally mounted on roller holders 41 at the lower portion of the right main frame 7. As mentioned before, the specific mounting hardware is merely one way of prac-tising the invention. Other suitable mounting hardware can be used so long as the action of the invention is carried out.

Figure 5 illustrates an end elevation view of the anode roller cleaner in a second position, where the top portions of the respective opposing main frames 7, 7 abut one another, while the bottom portions are spaced from one another. The opposing frames 7 are pivotable on the respective shafts 27. This is the position normally used for cleaning clips and adjacent areas of the anode 50.

The rotation of the top and bottom skeleton drums in any orientation can be hydraulically driven. Other suitable drive systems can also be used, if desired. As mentioned above, the rollers 12, 13, 14, 15 and 16 are mounted so that they can rotate around their longitudinal axis on respective roller holders 39 and 40. Other suit-able roller mounting mechanism can be used, so long as the objectives of the invention are implemented. Two identical

assemblies (see Figures 4 and 5) are mounted opposite and symmetrically relative to one another. The spacing between the rollers is such that the anode to be cleaned can be moved between them in a vertical manner. As anode 50 is moved vertically between the rollers (downwardly as shown in Figure 4), the rotating lower drums with their rollers 14, 15 and 16 impact the scale (not shown) on both sides of the anode 50 and dislodge the scale from each side.

Because of the length, weight and smooth surface of each roller, the rotatable action of each roller and the ability of the rollers to yield radially inwardly under excessive force (which exceeds the radially outward centrifugal force), the anode surface 50 is not damaged by having the yielding rotatable rollers impact on the anode scale on each side of the anode 50, and dislodge the scale at its interface with the surface of the anode 50. In other words, the rollers, by being held centrifugally in a radially extended position when the skeleton drums are rotated, and because they are rotatable, deliver a somewhat forgiving impact force on the scale. The rotational action also tends to smooth the surface of the anode 50.

The correct or optimum scale dislodging roller impact force, which is caused in large measure by the speed of rotation of the appropriate opposing skeleton drums, can be deduced by conducting minor tests. Clearly, as will be evident to a skilled artisan, the opposing skeletal drums carrying the upper rollers 12 and 13, or the opposing lower skeletal drums carrying the lower rollers 14, 15 and 16, as the case may be, should be rotated at an RPM sufficient to create a centrifugal force that holds the rotatable rollers in an extended position and causes them to impact the scale on the anode 50 with sufficient force to dislodge the scale. The RPM should be such that the rollers 12, 13, 14, 15 and 16 yield, that is, move inwardly on the respective mounting rods, if the impact force is too great.

The amount of scale that is removed is primarily determined by the spacing of the rollers. closer spacing gives more complete removal, even down to bare lead if needed (this is done for reject anodes that are to be remelted). Control of the spacing minimizes damage to the oxide layer for anodes that are placed back into the electrolytic cells. Too close a spacing offers more potential for damage than high RPM.

Also, the RPM is determined in relation to the rate of movement of the electrode through the roller cleaner. A low RPM in relation to a high rate of anode lowering gives inconsistent scale removal, as observed in intermittent "ripples" on the anode surface. The RPM can, of course, be varied to suit specific requirements and specific jobs. As a general rule, an RPM of about 400 to 2000 should suit most applications.

The two surfaces of the anodes 50 are flattened by the opposing yielding rollers. The protective lead oxide layer, which underlies the scale, is left relatively undisturbed. As the anode 50 is moved vertically upwardly or downwardly through the space or mouth between the opposing lower rollers 14, 15 and 16, the bottom rollers 14, 15 and 16 have continuous contact with the full width of the anode sheet 50, and thus a uniform cleaning of the surfaces of both sides of the anode occurs. As a general rule, the top set of rollers 12 and 13 is designed to clean the anode 50 in between the spacer clips only (not shown), thereby providing an allowance space so that the spacer clips remain intact and undamaged. The bottom rollers 14, 15 and 16 are typically used to clean the main surfaces of the anode 50. However, it will be understood that the procedure can be altered to suit the specific application. The cleaning motion also results in a flattening of the surfaces of the anode 50. This is desirable because a flat

surface gives more even electrical distribution in the cell.

Figure 6 illustrates a stylized end view of zinc anode 50 that has been cleaned using a rubber finger cleaner as disclosed and claimed in Canadian Patent No. 1,188,058. The scale 51 on each side of the anode 50 is rough and thick. This is undesirable because operating efficiency of the anode 50 is reduced, and cleaning procedures must be frequent, which results in increased "down-time" for the electrolytic cells.

Figure 7 illustrates a stylized end view of an anode 50 that has been cleaned using the anode roller cleaner according to the invention. As can be seen, the scale 51 remaining on both sides of the anode 50 is much thinner and smoother than the rough thick scale 51 which remains on both surfaces of the anode 50 after being cleaned using a rubber finger cleaner. This thinner remaining scale leads to improved scale cleaning, anode performance and reduced cleaning frequencies.

Construction Materials

The material chosen for construction of the assemblies must be sufficiently strong to carry the weight of the skeleton drums. The materials must also be durable enough to withstand acidic conditions (stainless steel is preferable). All moving parts, such as shafts and bearings, should be relatively friction free.

Examples

Example 1 - Results of Testing - Anode Cleaning

The anode cleaning system currently used by Cominco Ltd. consists of rubber fingers (chicken pluckers)

mounted on opposing rotating drums. Problems with this system include insufficient scale removal even after cleaning, as illustrated in Figure 6. This results in higher cleaning frequencies, short circuits which lead to a decrease in anode life and an increase in lead deportment to the zinc cathode.

As illustrated in Figure 7, the surfaces of a roller cleaned anode 50 according to the invention are smooth and uniform throughout. The anode surface is also flattened somewhat. Comparison tests between rubber finger cleaning and rotating roller cleaning have been conducted. Table 1 tabulates the quantity (weight) of scale removed using a rubber finger cleaner compared to a roller cleaner. As can be seen, the roller cleaner removes approximately 2-1/2 times as much scale.

Table 1

INCREASED CLEANING OF SCALE

Pounds of scale recovered per anode:	
Roller Cleaner (dry wt.)	Rubber Finger Cleaner
17.9 lbs/anode	6.9 lbs/anode

Example 2 - Flattening

Anodes produced by a rolled sheet method and cleaned using the roller anode cleaner exhibited a 6.3 mm improvement in flatness over those that were passed through the rubber finger cleaner. Anodes produced by a casting method showed a 4.4 mm improvement in flatness when run through the roller anode cleaner when compared to the rubber finger cleaner. These results are tabulated in Table 2.

Table 2

Type of Anodes	Number of Anodes Tested	Average Warp After Cleaning With Rubber Finger Cleaner (mm)	Average Warp After Cleaning With Roller Cleaner (mm)	Improvement (mm)
Rolled sheet	49	11.9	5.6	6.3
Cast	45	9.0	4.6	4.4

Example 3 - Lead in Cathode Zinc

A prototype demonstration confirmed that the roller anode cleaner produced a smooth uniform flat surface with most of the MnO_2 scale removed. For comparison purposes, two cells were filled, one with anodes cleaned by the rubber finger cleaner and the other containing anodes cleaned by the roller anode cleaner. This testwork demonstrated that there is marginally less lead deportment to cathode zinc in the cell containing roller cleaned anodes, compared to the cell containing rubber finger cleaned anodes, as quantified in Table 3.

Table 3

Pb DEPORTMENT

Pb Deportment	Pb in Cathode (ppm)	Pb in Electrolyte (mg/L)
Cell with roller cleaned anodes	10.4 ± 1.8	< 1
Cell with rubber finger cleaned anodes	11.2 ± 1.9	< 1

Example 4 - Current Efficiency

Current efficiencies were determined for the two cells described in Example 3 above. The cell with roller cleaned anodes exhibited higher C.E. at three different stages into the cleaning cycle, compared to the cell with rubber finger cleaned anodes. This is demonstrated in Table 4.

Table 4

CURRENT EFFICIENCY

Roller Cleaned Anodes (%)	Rubber Finger Cleaned Anodes (%)	Days into Cleaning Cycle (%)
91.6	90.6	18
89.1	83.7	50
88.1	87.1	53

Example 5 - Remelt of Reject Anodes

We have found that remelt of reject anodes is improved when reject anodes are cleaned using the roller cleaner. It has been observed after testing that the amount of dross formed as well as the amount of fume produced is decreased by as much as half when compared to rubber finger cleaned reject anodes. Therefore, plant hygiene is dramatically improved and a safer worker environment is provided. The recovery of silver and lead is also improved.

Other Factors

The end results of anodes cleaned with the roller cleaner are also improved. Visual inspection of anodes cleaned with the roller cleaner of the invention confirmed that the MnO_2 deposit that forms subsequently on anodes which have been roller cleaned is very smooth and dense. In comparison, anodes that have been cleaned with the rubber finger cleaner form a thicker and rougher MnO_2 deposit, on further use in a cell. The clear advantage with the roller cleaned anodes is that short circuits are less likely to occur with a smooth dense layer of MnO_2. It was also noted that the foam layer formed on the surface of the operating electrolysis cells equipped with roller cleaned anodes is dense with small bubbles. It appears therefore that a smooth and dense MnO_2 layer yields smaller gas bubbles. This phenomenon is advantageous for the containment of acid mist in the cellhouse, and thus provides an improvement in plant hygiene and operator conditions. The roller cleaner not only gives improved anode cleaning but the amount of MnO_2 scale removed can be controlled so as to optimize performance.

Performance Advantages

While a main objective of the anode roller cleaner of the invention is to uniformly remove scale deposit from the anode surface while leaving the underlying protective lead oxide layer on the anode surface relatively undisturbed, other advantages also occur. In summary, the cleaning mechanism provided by the roller cleaner has the following practical advantages:

1. Uniform improved cleaning of the anode surface;
2. Flattening of the anode surface;
3. Production of less dross when remelting reject anodes;
4. More uniform well-broken scale residue (MnO_2);
5. Improved plant hygiene and worker environment; and

6. No bruising of the anode sheet, which undesirably exposes bare lead.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

WHAT IS CLAIMED IS:

1. A method of cleaning scale from the surface of an electrode of an electrolytic cell comprising contacting the scale on the surface of the electrode with a smooth surface rotatable and yieldable member with a force which is sufficient to dislodge the scale from the electrode at the interface between the scale and the electrode and leaves the surface of the electrode intact.

2. A method as claimed in claim 1 wherein the electrode is an anode.

3. A method as claimed in claim 2 wherein the scale on the surface of the anode is contacted with a plurality of smooth surface yieldable members.

4. A method as claimed in claim 3 wherein the plurality of smooth surface yieldable members contact the scale on the surface of the anode in a sequential rotational manner by being mounted on the curved periphery of a rotating skeletal drum-like member.

5. A method as claimed in claim 4 wherein the plurality of smooth surface yieldable members are cylindrical rollers.

6. A method as claimed in claim 5 wherein the cylindrical rollers are hollow, and the hollow cylindrical rollers are mounted on cylindrical rods of diameter narrower than the diameter of the hollows in the rollers which rods extend through the hollows and rotatably mount the rollers on the curved periphery of the rotatable skeletal drum member.

7. A method as claimed in claim 6 wherein the plurality of first hollow rollers are mounted end to end in

series along a first longitudinal axis on the curved periphery of the skeletal drum member, said axis being parallel to the longitudinal axis of the rotating skeletal drum member.

8. A method as claimed in claim 7 wherein a plurality of second hollow rollers are mounted end to end in series on a second longitudinal axis on the curved periphery of the skeletal drum member said second axis being parallel with the first longitudinal axis and parallel with the longitudinal axis of the rotating skeletal drum member.

9. A method as claimed in claim 8 wherein a plurality of third hollow rollers are mounted end to end in series on a third longitudinal axis on the curved periphery of the skeletal drum member said third longitudinal axis being parallel with the first and second longitudinal axes, and parallel with the longitudinal axis of the rotating skeletal drum member.

10. A method as claimed in claim 9 including a plurality of fourth, fifth and sixth hollow rollers which are mounted end to end in series on parallel fourth, fifth and sixth longitudinal axes around the curved periphery of the skeletal drum member, and parallel with the first, second and third axes of the skeletal drum member.

11. A method as claimed in claim 10 including a second skeletal drum member and a second plurality of first, second, third, fourth, fifth and sixth rollers on the periphery thereof, the first and second pluralities of six rollers contacting opposite sides of the surface of the anode.

12. An apparatus for cleaning scale from the surface of an electrode comprising:

(a) a first frame;

(b) a second frame spaced from and facing the first frame (a) to provide a space between the first and second frames for passage of an electrode through the space;

(c) a first member rotatably mounted on the first frame on the side of the first frame facing the second frame;

(d) a second member rotatably mounted on the first frame on the side of the first frame facing the first frame;

(e) a rotatable, yieldable electrode contacting member mounted on the surface of the first member; and

(f) a rotatable, yieldable electrode contacting member mounted on the surface of the second member; said first rotatable yieldable member and said second rotatable yieldable member impacting on respective first and second sides of the electrode as the electrode is passed through the space between the first and second frames.

13. An apparatus as claimed in claim 12 wherein the electrode is an anode.

14. An apparatus as claimed in claim 13 wherein the first member and the second member have a skeletal cylindrical drum-like configuration, and the axes of rotation for the first and second members are transverse to the direction of passage of the anode through the space between the first frame and second frame.

15. An apparatus as claimed in claim 13 wherein the rotatable yieldable member is a roller, the axis of rotation of which is parallel to the first member (c).

16. An apparatus as claimed in claim 15 wherein the rotatable yieldable member is a second roller, the axis of rotation of which is parallel to the second member (d).

17. An apparatus as claimed in claim 14 wherein the rotatable yieldable member is a roller, the axis of rotation of which is parallel to the first member.

18. An apparatus as claimed in claim 17 wherein the rotatable yieldable member is a second roller, the axis of rotation of which is parallel to the second member.

19. An apparatus as claimed in claim 16 wherein the first and second rotatable members have a generally hollow skeletal drum-like configuration, and the axis of rotation of the first and second members is transverse to the direction of passage of the anode through the space between the first and second members.

20. An apparatus as claimed in claim 14 wherein the first drum-like member has six hollow cylindrical rollers spatially mounted around the periphery of the first drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

21. An apparatus as claimed in claim 20 wherein the second drum-like member has six hollow cylindrical rollers spatially mounted around the periphery of the second drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

22. An apparatus as claimed in claim 21 wherein the first and second drum-like members are mounted on first and second shafts which are rotatably mounted in the respective first and second frames.

23. An apparatus as claimed in claim 22 wherein the first and second rollers are hollow cylinders and are rotatably mounted on the peripheries of the first and second drum-like members by shafts which pass through the hollow interiors of the respective first and second rollers, said shafts being affixed to the ends of the first and second drum-like members.

24. An apparatus as claimed in claim 13 wherein the first frame has first and third members rotatably mounted thereon in series and the second frame has second and fourth members rotatably mounted on the second frame in series thereon.

25. An apparatus as claimed in claim 24 wherein the first frame and the second frame can be pivoted relative to one another so that the top of the first frame and the second frame abut one another in a first position, and alternatively, the bottom of the first frame and the bottom of the second frame abut one another when the first and second frames are pivoted to a second position.

26. An apparatus for cleaning scale from the surface of an anode comprising:

(a) a main frame;

(b) a first drum rotationally mounted on the main frame; and

(c) a first roller rotationally mounted on the surface of the drum, said roller being movable in a radial direction, and having an axis of rotation which is parallel to the axis of rotation of the drum, the roller impinging on the scale of the anode and separating the scale from the anode.

27. An anode cleaner as claimed in claim 26 including an opposing main frame, second rotating drum and second

rotating roller, a space being provided between the opposing first and second drums and rollers to enable an anode to be passed through the space, the first and second rollers impinging on each side of the anode to remove scale from both sides of the anode.

28. An anode cleaner as claimed in claim 27 wherein the first and opposing main frames include corresponding third and fourth rotating drums parallel with and spaced from the first and second rotating drums, the third and fourth drums having rotationally mounted thereon third and fourth rollers which rotate about axes which are parallel with the axis of rotation of the third and fourth drums.

29. An anode cleaner as claimed in claim 28 wherein each of the drums has disposed around the circumference thereof at equal intervals six rollers, which are rotationally mounted on respective roller holders.

30. An anode cleaner as claimed in claim 29 wherein the drums are each constructed of a series of circular plates, spatially and radially disposed along an axle, and a plurality of rollers rotationally mounted on roller holders extending between the series of radially disposed plates.

31. An anode cleaner as claimed in claim 30 wherein the rollers are hollow cylinders and the roller holders are rods extending through the interior of the hollow cylinders.

32. An anode cleaner as claimed in claim 31 wherein the first and second drums are each constructed of a series of three sided spacer plates, spatially and radially disposed along a second axle rotationally mounted in the main frame at a level below the first axle, the spacer plates having mounted on the peripheral edges thereof in equidis-

tant relationship rollers mounted on shafts extending between peripheral edges of the spacer plates.

33. An anode cleaner as claimed in claim 32 wherein the rollers are hollow cylinders which rotate on correspon-ding roller rods extending between peripheral points on the spacer plates.

34. An anode cleaner as claimed in claim 28 wherein the distance between the first main frame and the opposite main frame can be adjusted.

35. An anode cleaner as claimed in claim 32 wherein the spacer plate has a general isosceles triangular shape, rollers and roller mounting rods are mounted in the general region of the points of the isosceles triangle, and the spacer plates are arranged radially and spatially along the lengths of the second shafts alternate in position so that rollers are disposed at 60° positions around the circumfer-ence of the second drum.

36. An apparatus for cleaning anodes comprising:

(a) a first frame;

(b) a second frame spaced from and facing the first frame to provide a space between the two frames for passage of an anode through the space;

(c) a first drum-like member rotatably mounted on the first frame on the side of the frame facing the second frame; the first drum-like member having six hollow cylin-drical rollers mounted around the periphery of the first drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames;

(d) a second drum-like member rotatably mounted on the first frame below the first drum-like member on the

side of the frame facing the second frame, the second drum-like member having six hollow cylindrical rollers mounted around the periphery of the second drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis of rotation of the drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames;

(e) a third drum-like member rotatably mounted on the second frame on the side of the frame facing the first frame; the third drum-like member having six hollow cylindrical rollers mounted around the periphery of the third drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the third drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames; and

(f) a fourth drum-like member rotatably mounted on the second frame below the third drum-like member on the side of the frame facing the first frame, the fourth drum-like member having six hollow cylindrical rollers mounted around the periphery of the fourth drum-like member, the six rollers having axes of rotation parallel with one another, parallel with the axis rotation of the fourth drum-like member, and transverse to the direction of passage of the anode through the space between the first and second frames.

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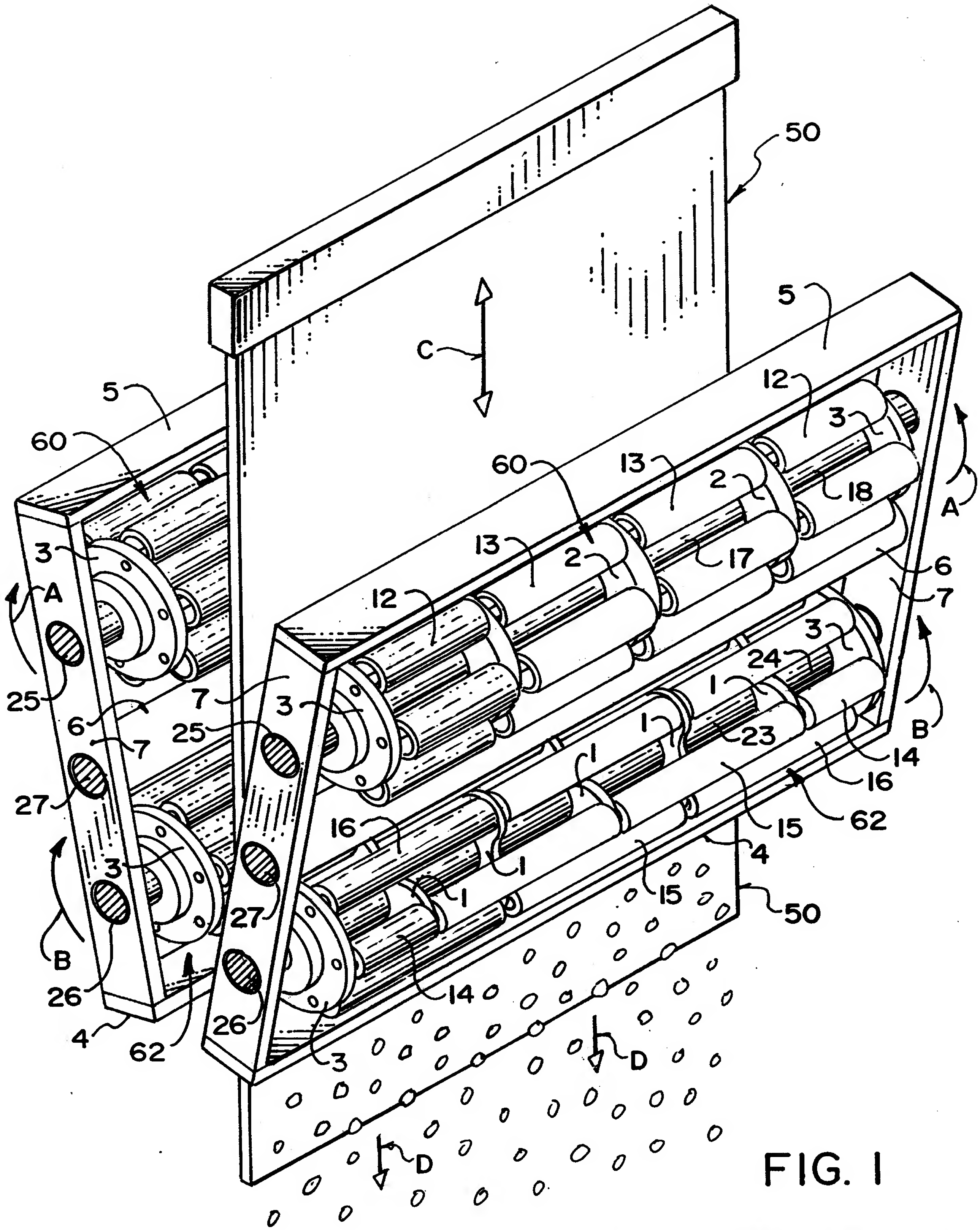

FIG. 1

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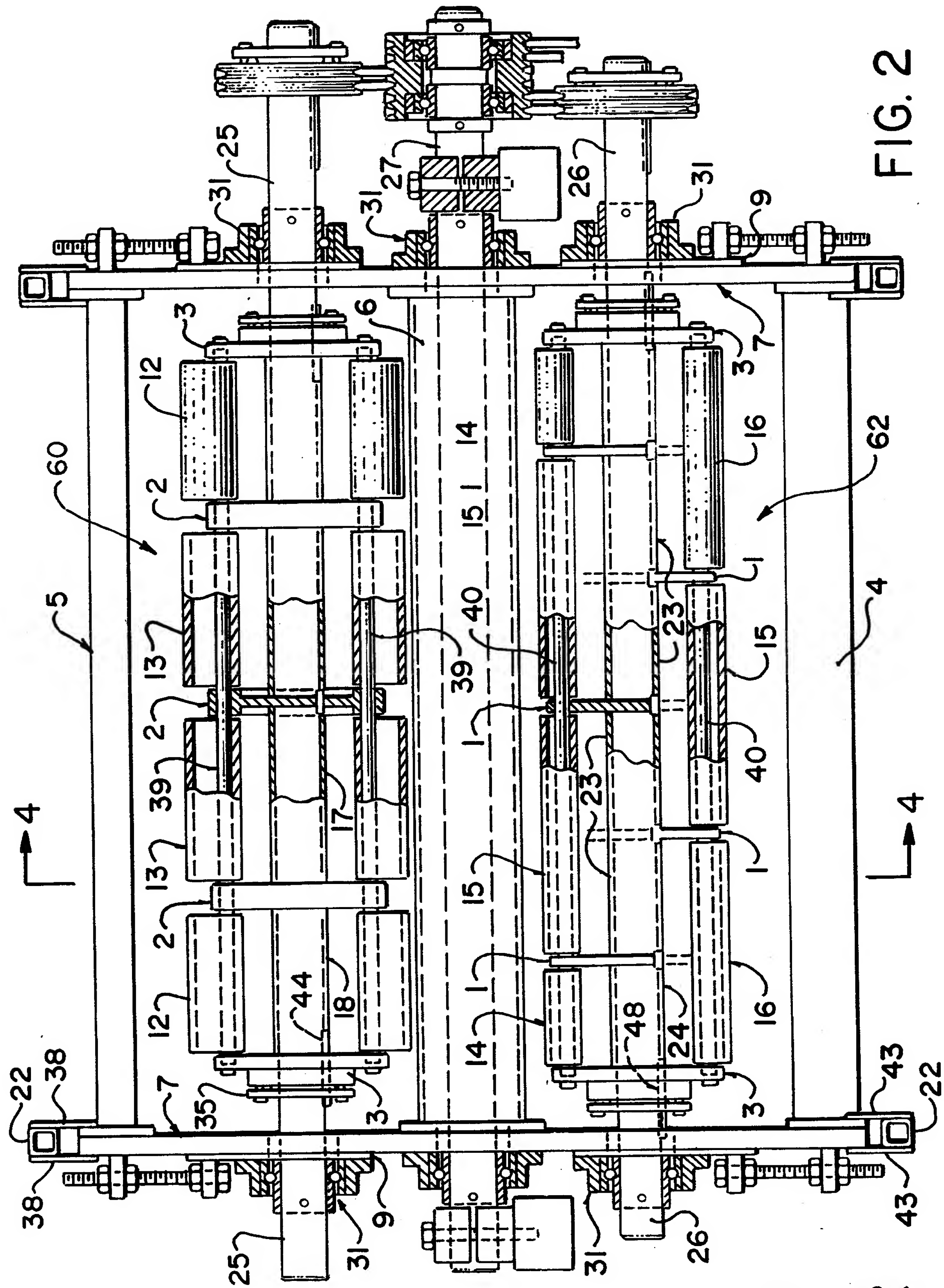

FIG. 2

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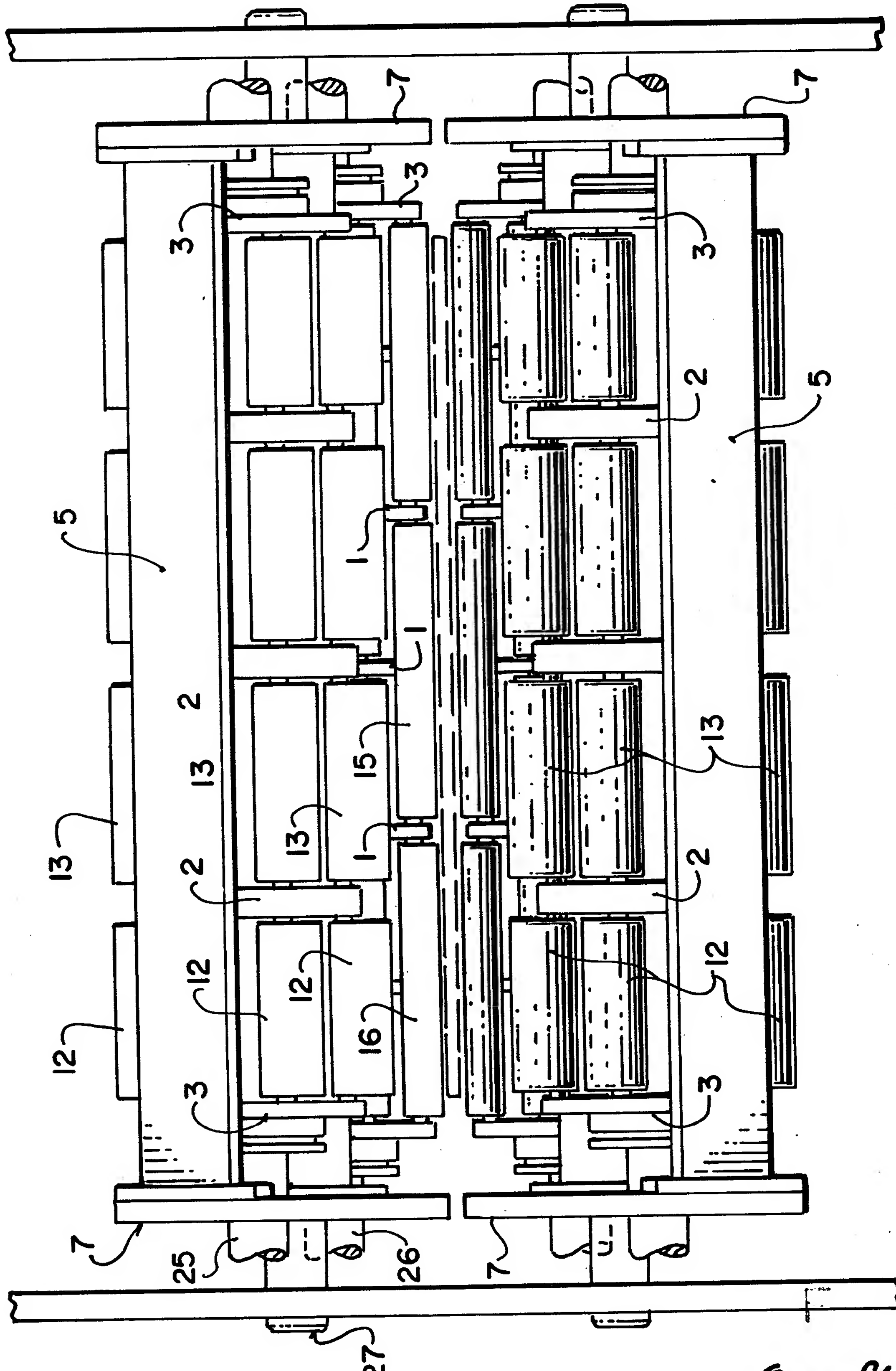

FIG. 3

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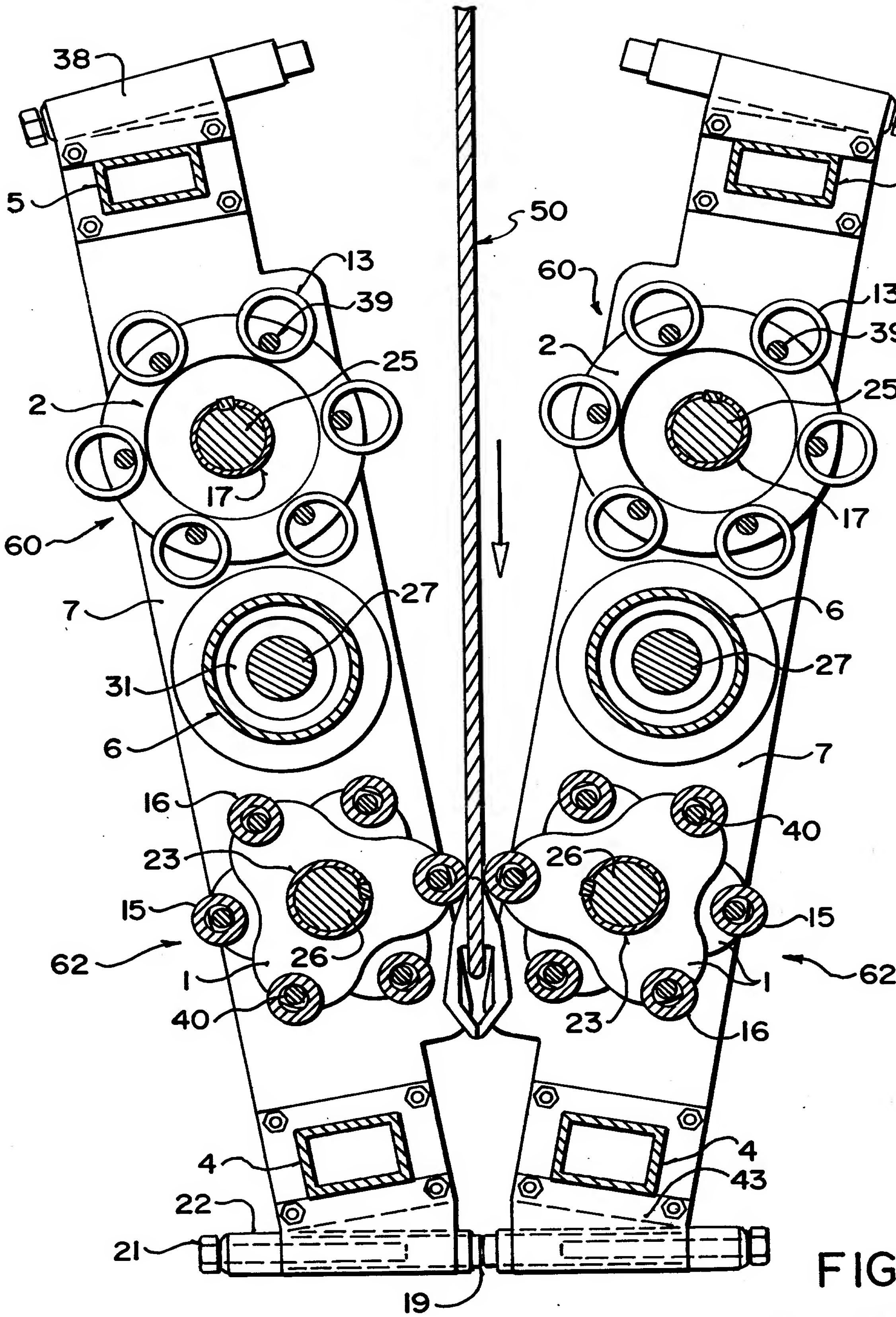

FIG. 4

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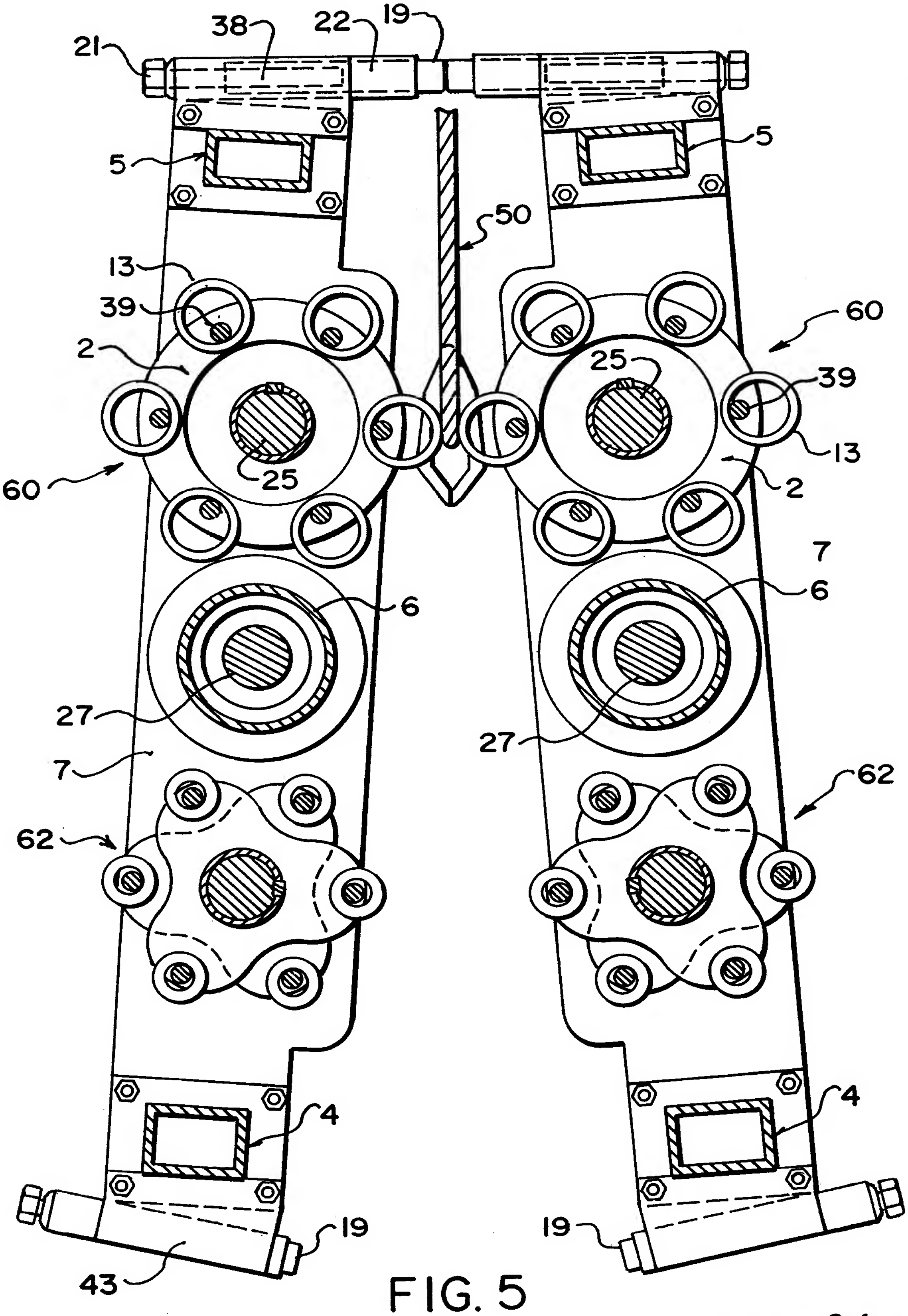

FIG. 5

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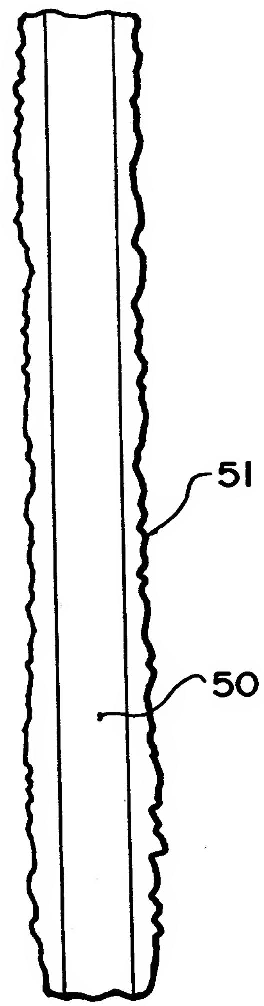

FIG. 6

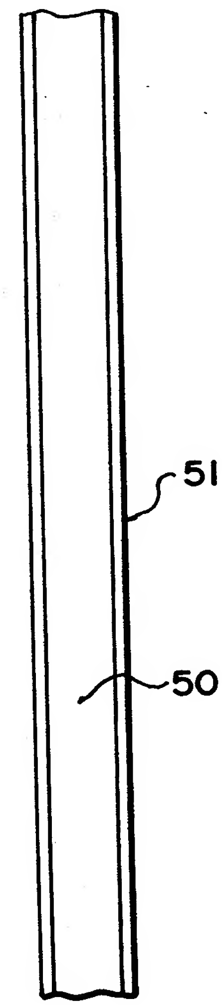

FIG. 7

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DERWENT-ACC-NO: 1997-435854

DERWENT-WEEK: 199741

TITLE: Electrolytic cell electrode cleaner with the electrodes cleaned by rollers which remove the scale while leaving undisturbed the underlying lead oxide layer.

INVENTOR: BONDEROFF K P

PATENT-ASSIGNEE: COMINCO LTD[CMSC]

PRIORITY-DATA: 1995CA-2164910 (December 11, 1995)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE
CA 2164910 A	June 12, 1997	EN

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
CA 2164910A	N/A	1995CA-2164910	December 11, 1995

INT-CL-CURRENT:

TYPE	IPC DATE

CIPS C25C7/06 20060101

ABSTRACTED-PUB-NO: CA 2164910 A

BASIC-ABSTRACT:

A method of cleaning scale from the surface of an anode of an electrolytic cell comprises contacting the scale on the surface of the anode with smooth surfaced hollow cylindrical rollers with a force which is sufficient to dislodge the scale from the anode at the interface between the scale and the anode while leaving the surface of the anode intact. The cylindrical rollers are mounted on cylindrical rods of diameter narrower than the diameter of the hollows in the rollers which rods extend through the hollows and rotatably mount the rollers on the curved periphery of rotatable skeletal drum members rotating transverse to the anode travel.

Also claimed is an apparatus for cleaning scale from the surface of an electrode.

USE - A roller cleaner for cleaning scale from electrodes.

ADVANTAGE - Scale deposit is uniformly removed from the anode surface while leaving the underlying protective lead oxide layer on the anode surface relatively undisturbed. The cleaning mechanism provided by the roller cleaner provides (1) uniform improved cleaning of the anode surface. (2) flattening of the anode surface. (3) production of less dross remelting reject anodes. (4) more uniform well broken scale residue (5)

improved plant hygiene worker environment. (6) no bruising of the anode sheet which undesirably exposes bare lead.

CHOSEN-DRAWING: Dwg.1,4/7

TITLE-TERMS: ELECTROLYTIC CELL ELECTRODE CLEAN ROLL REMOVE SCALE LEAVE UNDISTURBED UNDERLYING LEAD OXIDE LAYER

DERWENT-CLASS: M28 X25

CPI-CODES: M28-C02;

EPI-CODES: X25-R02;

SECONDARY-ACC-NO:

CPI Secondary Accession Numbers: 1997-139836

Non-CPI Secondary Accession Numbers: 1997-362427